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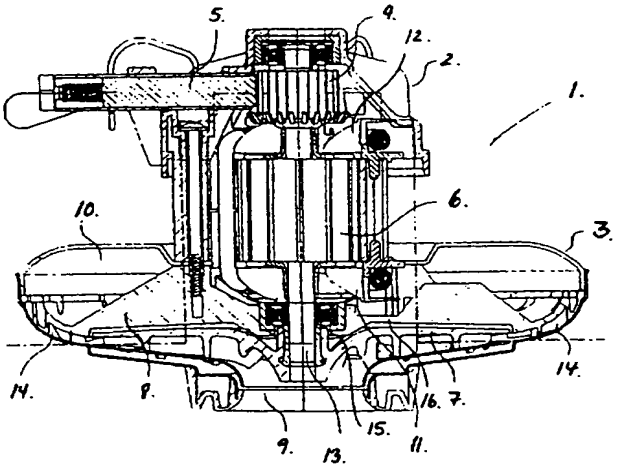

(57) Abstract

A vacuum cleaner blower (1) with a blower wheel (7) and a motor (2) arranged for rotating the blower wheel (7) abuts its axis of symmetry (13), and a diffuser (8) extending radially beyond the outer periphery of the blower wheel (7), and wherein the diffuser (8) has guide surfaces (17, 18) which form diffusion flow passages (14) that define the flow direction for the air conveyed through the diffuser (8) from the blower wheel (7), said flow direction being anywhere in the diffuser flow passage (14) definable by velocity components in radial, axial and tangential directions, respectively, relative to the axis of rotation (13) of the blower (7). The diffuser flow passages (14) according to the invention formed by the guide surfaces (17, 18) being so provided that they convey the flow of air in such a manner that the velocity component of the flow in the axial direction relative to the velocity component of the flow in the radial direction is higher at the outlet opening of the diffuser flow (14) than at the inlet opening, makes it possible in case of given installation dimensions to design an efficient diffuser while simultaneously providing the blower wheel with a relatively large outer periphery.

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A blower for a vacuum cleaner

The present invention relates to blowers for use in suction cleaners, such as vacuum cleaners, and which are herein designated blowers for a vacuum cleaner, comprising a blower wheel and a motor arranged for rotating the blower wheel about its axis of symmetry, and a diffuser extending radially beyond the outer periphery of the blower wheel, and wherein the diffuser has guide surfaces that form diffuser flow passages which define the flow direction for the air conveyed through the diffuser from the blower wheel, which flow direction being anywhere in the diffuser flow passage definable by velocity components in the radial, axial and tangential directions, respectively, relative to the axis of rotation of the blower.

Such blowers for vacuum cleaners are known today i.a. from EP-A1-467 557 wherein the blower wheel conventionally serves to accelerate the air velocity to a maximum velocity and thus kinetic energy at the periphery of the blower wheel, and wherein a diffuser is provided beyond the periphery of the blower wheel, which diffuser extends substantially perpendicular to the axis of rotation of the blower wheel, and subsequently serves to convert the kinetic energy of the air (velocity energy) at the inlet openings of the diffuser to potential energy (gas pressure) at the outlet openings of the diffuser by the flow of air flowing through diffuser flow passages having evenly increasing cross sectional areas.

In connection with suction cleaners today, efforts are made to increase the suction capacity of the suction cleaner, i.a. by utilising motors with higher rpm or by minimising the pressure loss in the flow passages through the suction cleaner by minimising the leaks and

optimising the flow paths and the performance. However, the confined installation dimensions most often available in suction cleaners render the task of optimisation extremely difficult, and consequently many compromises are made in this field.

In this context the diffuser is an important unit as it enables the conversion of kinetic energy into potential energy to take place without substantial flow losses compared to blower constructions where no diffusers are used but exclusively guide passages without or with only a small diffuser performance. Since the performance of the diffuser flow passages is increased, ceteris paribus, as the length of the diffuser flow passages increases relative to the difference in area of the inlet and outlet openings, it is obvious that the person skilled in the art may, according to given installation conditions, choose to give priority to a large blower wheel diameter or relatively long diffuser flow passages. Most often this choice will, ceteris paribus, be in favour of the blower wheel with the result that today the diffusers in blowers for a vacuum cleaner have relatively low performances, typically below 50%.

If it is chosen to have a blower wheel with a small diameter, it is necessary, as known in the most common vacuum cleaner blower constructions, to use a multiple-step blower construction wherein the air is caused to flow through both blowers to compensate for the lacking increase in pressure of the individual blower. However, ceteris paribus, this entails a considerably more complex construction and reduced efficiency.

In the light of this it is the object of the present invention to provide a vacuum cleaner blower of the type featured in the introductory part of claim 1 whereby it

is possible, ceteris paribus, to obtain an increased efficiency and an increase in pressure by using only one blower wheel.

This is obtained by the fact that the vacuum cleaner blower is provided in accordance with the features described in the characterising portion of claim 1 whereby the diffuser flow passages formed by the guide surfaces are caused to deflect in such a manner that they convey the flow of air in such a manner that the velocity component of the flow in the axial direction relative to the velocity component in the radial direction at the outlet opening exceeds the velocity at the inlet opening. In this manner it is possible with given installation dimensions around a blower wheel to obtain longer diffuser passages than was possible, ceteris paribus, with e.g. the plane diffuser known from the above-mentioned EP-A1-467 557.

In a preferred embodiment the guide surfaces which constitute each of the diffuser flow passages are provided in such a manner that the radial velocity component of the flow substantially equals zero at the outlet opening of the diffuser flow passages. Thereby the diffuser flow passages may in a simple manner be caused to debouch into a chamber below the blower wheel without necessitating that the outer diameter of the vacuum cleaner blower has to be substantially larger than the outer diameter of the diffuser.

By arranging the outlet openings of the diffuser flow passages at such distance from the axis of symmetry of the blower wheel which is larger than the corresponding distance of the inlet openings, the diffuser may be provided in an extremely production-friendly manner of a plastics material in an injection-moulding process.

According to a preferred embodiment which provides a particularly high performance, the vacuum cleaner blower is provided in such a manner that the guide surfaces which form each of the diffuser flow passages are so provided that the velocity components of the flow at the inlet opening substantially correspond to the velocity components of the flow at the periphery of the blower wheel. Additionally the performance may also be increased by the diffuser flow passages between the inlet opening and the outlet opening being in the form of continuously extending passage deflections.

In particular, the advantages of the invention are significant in connection with blowers for a vacuum cleaner which are operated by blower wheels that rotate with a speed of rotation which is relatively low for blowers for a vacuum cleaner but wherein the blower wheel has a relatively large outer diameter due to the relatively low speed of rotation. Thereby the invention is specifically suitable in connection with blower wheels that comprise to substantially disc-shaped guide surfaces which are spaced apart by means of blower blades, and wherein the guide surfaces have an outer diameter which forms the periphery of the blower wheel and said diameter exceeding 140 mm and being less than 160 mm, and that the distance between the disc-shaped guide surfaces at the periphery of the blower wheel exceeds 2,5 mm and is less than 4 mm, preferably 3 mm. At an rpm for the blower wheel of between 18000 rpm and 28000 rpm and despite the relatively small distance between the guide surfaces which in itself causes a relatively large friction in the flow, such embodiment will be substantially optimum whereby electric motors may be used with a relatively small rpm and, ceteris paribus, from an overall point of

view an increased longevity for the motor and thus for the blower is obtained.

In this context, it is preferred that the distance between the guide surfaces which delimit the diffuser flow passages in the same direction as the disc-shaped guide surfaces of the blower wheel substantially equals the distance between the disc-shaped guide surfaces of the blower wheel. Thereby the energy loss in the transition between the blower wheel and the diffuser is reduced. This energy loss is further reduced by the outlet angle of the blower blades on the blower wheel being larger than 25° and smaller than 35°, preferably 30°, and that the guide surfaces which separate the diffuser flow passages from each other have an inlet angle which is larger than 10° and smaller than 20°, preferably 15°, wherein said preferred embodiments have a particularly high efficiency, typically of more than 60% at the interval stated for the rpm of the blower wheel.

According to a further preferred embodiment of the present invention, the inlet openings of the diffuser flow passages are arranged at a distance from the periphery of the blower wheel which exceeds 5 mm. Hereby the noise which may be generated in the area between the guide surfaces which form the diffuser flow passages and the blower wheel may be reduced without significantly influencing the efficiency of the blower.

The invention will be described in further detail with reference to the drawings, where

Figure 1 is a sectional view through a vacuum cleaner blower according to the invention.

Figure 2 is a side view of a preferred embodiment of a diffuser element for the vacuum cleaner blower according to Figure 1.

Figure 3 is a top plan view of the diffuser element according to Figure 2.

Figure 4 is a side view of a preferred embodiment of a blower wheel for the vacuum cleaner blower according to Figure 1.

Figure 5 is a top plan view of the blower wheel according to Figure 4.

Thus Figure 1 illustrates a preferred embodiment of a vacuum cleaner blower 1 according to the invention. The vacuum cleaner blower has a motor 2 which is an electro-motor with a commutator 4 herein which is powered in a conventional manner with current from a number of coals 5 of which only one is illustrated herein. Moreover, in a known manner the motor 2 comprises an armature 6 which may rotate about a shaft 13.

At a usual load, electro-motors of this type for blowers for a vacuum cleaner operate within the range of from 18000 rpm to 28000 rpm. In the embodiment shown the present invention is particularly suitable for use in connection with motors that operate within this interval, but of course it may also lend itself for use in connection with other types of motors, such as motors which may operate at an rpm which is outside the range defined above.

At the one end of the motor 2, blower housing is arranged having a suction opening 9 which, in a known manner in e.g. a vacuum cleaner, debouches in the dust collecting

chamber of the vacuum cleaner. The present invention being in principle suitable for any type of vacuum cleaner, this is not exemplified in the drawings. In the shaft 13 of the motor a blower wheel 7 is mounted as will be described in further detail with reference to Figures 4 and 5 but which serves to draw in air via the suction opening 9 and to accelerate this air to obtain maximum velocity at the periphery of the blower wheel 7.

Moreover the blower housing 3 is provided in a manner known per se with a diffuser 8 arranged around the blower wheel 7, which diffuser will be subject to more detailed description with reference to Figures 2 and 3 but having in a known manner a number of diffuser passages 14 which each has an inlet opening opposite the periphery of the blower wheel 7, and an outlet opening which debouches in a chamber 10 arranged in the blower housing 3 whereby the diffuser passages 14 are caused to convey the air flung from the blower wheel 7 at high velocity into the chamber 10 of the blower housing 3.

In a known manner the individual diffuser passages 14 have a cross sectional area which is smallest at the inlet opening and largest at the outlet opening which means that the air which flows into the passage at high velocity (kinetic energy) is caused to flow out of the passage at a relatively lower velocity (kinetic energy) but at an increased gas pressure (potential energy). Thus, during operation an elevated gas pressure is generated in the gas chamber 14 compared to the suction opening 9 whereby the air is allowed to be pressed out of the chamber 14 substantially without any loss and further on through the suction cleaner.

In the embodiment of the vacuum cleaner blower shown, the air is drawn via passages 11 through the motor 2 and thus

cools the latter following which it conveyed away from the motor 2 via passages 12. Obviously, it is an advantage in connection with vacuum cleaners that the motor 2 is cooled in this manner, but it goes without saying that the invention lends itself for use in connection with e.g. wet suction machines wherein it is desired to eliminate the risk that the motor is flushed by humid air or fluid, which is why they are provided with a separate cooling blower for cooling the motor, and thus in this situation it is possible that the flow of air from the chamber 10 avoids the motor 2 completely.

The diffuser 8 will now be described in detail with reference to Figures 2 and 3 which illustrate the diffuser 8 seen from the side and from the top from that side to which the blower wheel is arranged in Figure 1, respectively. Thus, the diffuser 8 has a central opening for receiving the shaft 13 of the motor 2 as shown in Figure 1. Moreover it has a partition wall 16 serving to divide the blower housing 3 into two chambers, viz. a first chamber in which the blower wheel is arranged as shown in Figure 1 and the chamber 14.

As stated above, the periphery of the diffuser 8 is provided with diffuser flow passages 14, since here the diffuser is provided with a number of guide surfaces 17 which extend in the area between the lower guide surface 18 and the blower housing 3, whereby the diffuser flow passages 14 are substantially separated from each other whereby the guide surfaces 17 and 18 of the diffuser 8 form the diffuser flow passages 14 in combination with the blower housing 3.

As will appear from Figures 1, 2 and 3, the diffuser 8 in combination with the blower housing 3 form the diffuser flow passages 14 extending at the periphery of the blower

wheel 7 substantially in the plane of the blower wheel 7 outwards relative to the axis of rotation or symmetry of the blower wheel, which is defined by the shaft 13 on the motor 2. Relative to this axis of rotation or symmetry, the diffuser flow passages 14 convey the air in such direction and at such velocity which may in essence be defined by a radial and tangential velocity component, the axial velocity component being extremely small or zero. In contrast, the diffuser flow passages 14 are so designed that the air is conveyed into the chamber 10 at such velocity and in such direction which are primarily defined by an axial and a tangential component of direction, the radial component of velocity at the outlet being extremely small or zero. As will appear from Figures 2 and 3 this has been obtained with a preferred embodiment wherein the diffuser flow passages 14 are deflected into a three-dimensional passage deflection that consists of smooth continuously extending surfaces 17,18 for flow considerations, said surfaces having no abrupt bends which may result in flow losses.

According to the invention this three-dimensional shape of the passage enables use of a blower wheel 7 with a relatively large outer diameter compared to known constructions without necessitating that the blower housing 3 should have a correspondingly increased diameter in order to make room for the known diffuser passages which provide only a diffuser effect. Moreover it is possible to let the diffuser flow passages 14 convey the air to the chamber 10 substantially without losses.

Reference is now made to Figures 4 and 5 which illustrate a preferred embodiment of a blower wheel 7 for the vacuum cleaner blower according to the invention wherein Figure 5 illustrates the blower wheel 7 seen from the suction

opening 9. The blower wheel 7 has a central mounting site 19 for attachment of the blower wheel 7 to the shaft 13 of the motor (2) as shown in Figure 1. In the preferred embodiment shown the blower wheel has a lower unit 20 which is preferably made in an injection moulding process, in particular a plastics injection moulding process wherein, of course, the lower unit is made of plastics.

The lower unit 20 on the blower wheel 7 may thus be made with a very high degree of freedom, thus allowing blower blades 21 to be arranged in a simple manner and which extend in a conventional manner in radii originating in the suction opening end extending to the periphery of the blower wheel 7. To these blower blades 21 a cover plate 22 is subsequently attached in selected receiving points 23, which cover plate is preferably made of metal. The cover plate 22 will hereby brace the relatively flexible lower unit 20 which will, as stated above, be made of plastics. In this way maximum advantage is taken of the properties of the plastics and the metal to form a light but strong blower wheel 7. This advantage is further supported by the preferred embodiment shown wherein the cover plate 22 is made as a conical surface which will thereby further brace the lower unit 20.

This is important in particular in connection with the embodiment shown of the blower wheel 7 as well as the diffuser 8, since this embodiment necessitates a very small distance between the cover plate 22 and the lower unit 20 at the outer periphery of the blower wheel due to the outer diameter of the blower which is relatively large for vacuum cleaner blowers, which distance is advantageously between 2 mm and 4 mm and in the embodiment shown 3 mm.

This very small distance will of course cause the skilled person to be concerned that an inconveniently large friction will occur in the flow between the cover plate 22 and the lower unit 20. Since, however, it is possible according to the invention to impart to the blower wheel a particularly large outer diameter whereby the radial flow from the blower wheel becomes relatively small, this aspect is of minor importance while, at the same time, the large diameter of the blower wheel 7 does not make it necessary to have too short diffuser flow passages 14 but still makes it possible to obtain a diffuser effect substantially with out losses.

Obviously, this also presupposes that blower wheel 7 as well as diffuser 8 are configured to be optimum from a flow point of view, and therefore the preferred embodiment shown in Figures 1 through 5 will be described in further detail in the following with regard to the design of the blower wheel 7 and the diffuser 8.

Thus in the embodiment shown, the inlet opening 9 on the blower wheel 7 has a diameter of 43 mm and an outer diameter of 150 mm. The outlet angle of the blower blades 21 at the outer periphery of the blower wheel 7 is 30° in the embodiment shown relative to the tangent at the same point on the periphery.

In order to ensure the most smooth transition possible, the passage height on the diffuser flow passages 14 equals or slightly exceeds the distance between the cover plate 22 and the lower unit 20 in the blower wheel, i.e. about 3 mm. As stated above, in the preferred embodiment of the blower wheel 7 the diffuser passages 14 will be optimum at an inlet angle of 15° relative to the corresponding tangent direction.

Obviously it will be possible for the skilled person to exercise the invention with its ensuing advantages for blowers with other dimensions than those stated above, but practical tests have shown that the embodiment shown is optimum despite the concern that so small passage heights may entail increased friction in the flow passages. In particular in case of slowly operating motors, the embodiment shown is optimum since, despite the lower rpm, the large outer diameter of the blower wheel 7 results in a large peripheral velocity for the air leaving the blower wheel and is urged into the diffuser, and thus in a high gas pressure.

C l a i m s

1. A vacuum cleaner blower (1) with a blower wheel (7) and a motor (2) arranged for rotating the blower wheel (7) about its axis of symmetry (13), and a diffuser (8) extending radially beyond the outer periphery of the blower wheel (7), and wherein the diffuser (8) has guide surfaces (17,18) which form diffuser flow passages (14) that define the flow direction for the air conveyed through the diffuser (8) from the blower wheel (7), said flow orientation being anywhere in the diffuser flow passage (14) definable by velocity components in the radial, axial and tangential directions, respectively, relative to the axis of rotation of the blower (7), c h a r a c t e r i z e d in that the diffuser flow passages (14) formed by the guide surfaces (17,18) are so provided that they convey the flow of air in such a manner that the velocity component of the flow in the axial direction relative to the velocity component in the radial direction is higher at the outlet opening of the diffuser flow (14) than at the inlet opening.

2. A vacuum cleaner blower according to claim 1, c h a r a c t e r i z e d in that the guide surfaces (17,18) which form each of the diffuser flow passages (14) are so provided that the radial velocity component of the flow substantially equals zero at the outlet opening of the diffuser flow passage (14).

3. A vacuum cleaner blower according to any one of the preceding claims, c h a r a c t e r i z e d in that the outlet openings of the diffuser flow passages (14) are arranged at a distance from the axis of symmetry (13) of the blower wheel (7) which distance exceeds the corresponding distance of the inlet openings.

4. A vacuum cleaner blower according to any one of the preceding claims, c h a r a c t e r i z e d in that the guide surfaces (17,18) which form each of the diffuser flow passages (14) are so provided that the velocity components of the flow at the inlet opening correspond substantially to the velocity components in the flow at the periphery of the blower wheel (7).

5. A vacuum cleaner blower according to one of the preceding claims, c h a r a c t e r i z e d in that the diffuser flow passages (14) between the inlet opening and the outlet opening are in the form of a continuously extending passage deflection.

6. A vacuum cleaner blower according to any one of the preceding claims, c h a r a c t e r i z e d in that the blower wheel (7) comprises two substantially disc-shaped guide surfaces (20,22) which are spaced apart by means of blower blades (21), and wherein the guide surfaces (20,22) have an outer diameter which constitutes the periphery of the blower wheel (7), and said diameter exceeding 140 mm and being less than 160 mm, preferably 150 mm, and that the distance between the disc-shaped guide surfaces (20,22) at the periphery of the blower wheel (7) exceeds 2 mm and is less than 4 mm, preferably 3 mm.

7. A vacuum cleaner blower according to claim 6, c h a r a c t e r i z e d in that the distance between the guide surfaces (18,3) which delimit the diffuser flow passages in the same direction as the disc-shaped guide surfaces of the blower wheel substantially equals the distance between the disc-shaped guide surfaces (20,22) of the blower wheel (7).

8. A vacuum cleaner blower according to claim 6, c h a r a c t e r i z e d in that the outlet angle of the blower blades (21) at the periphery of the blower wheel (7) exceeds 25° and is less than 35°, preferably 30°.

9. A vacuum cleaner blower according to claim 8, c h a r a c t e r i z e d in that the guide surfaces (17) which separate the diffuser flow passages (14) from each other have inlet angles which exceed 10° and are less than 20°, preferably 15°.

10. A vacuum cleaner blower according to any one of the preceding claims, c h a r a c t e r i z e d in that the inlet openings of the diffuser flow passages (14) are arranged at a distance from the periphery of the blower wheel (7) which exceeds 5 mm.

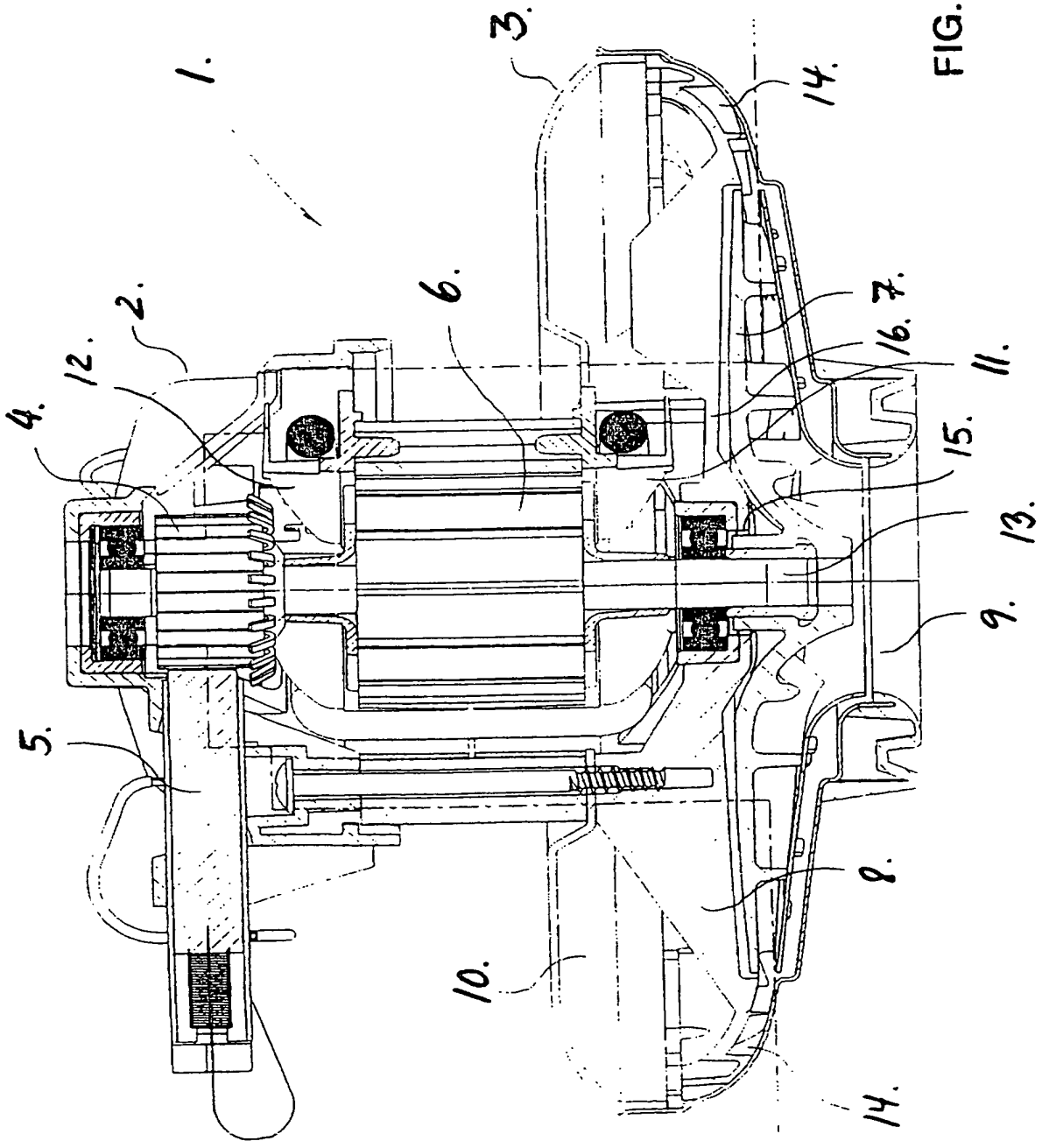

FIG. 1

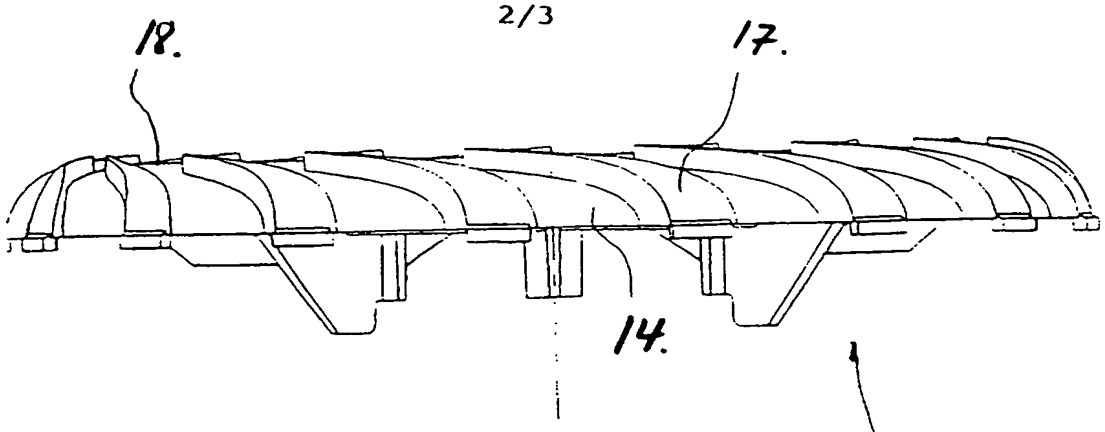

FIG. 2

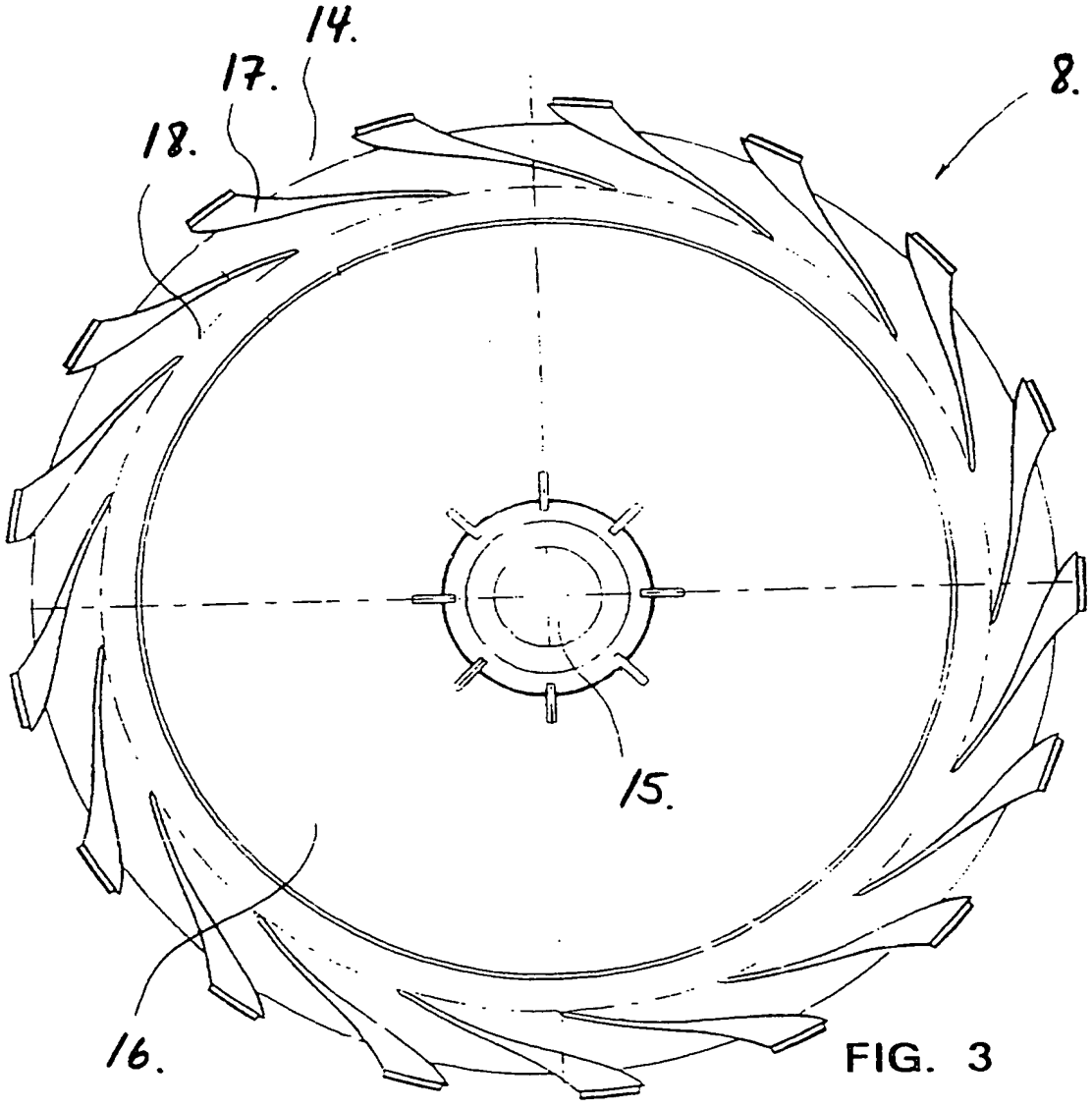

FIG. 3

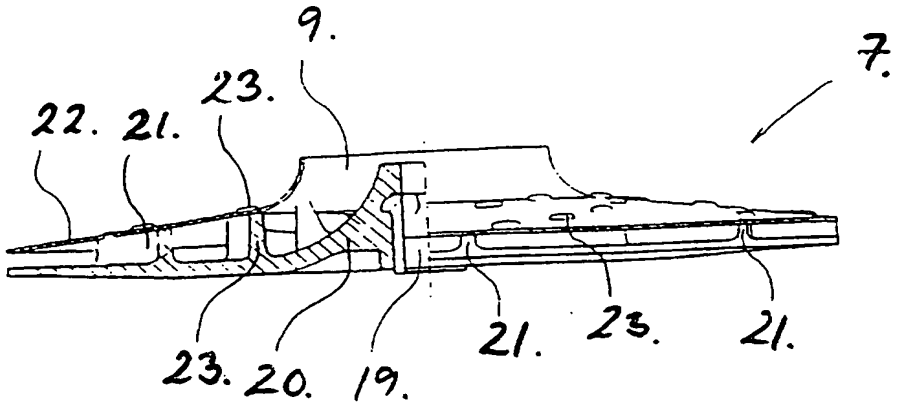

FIG. 4

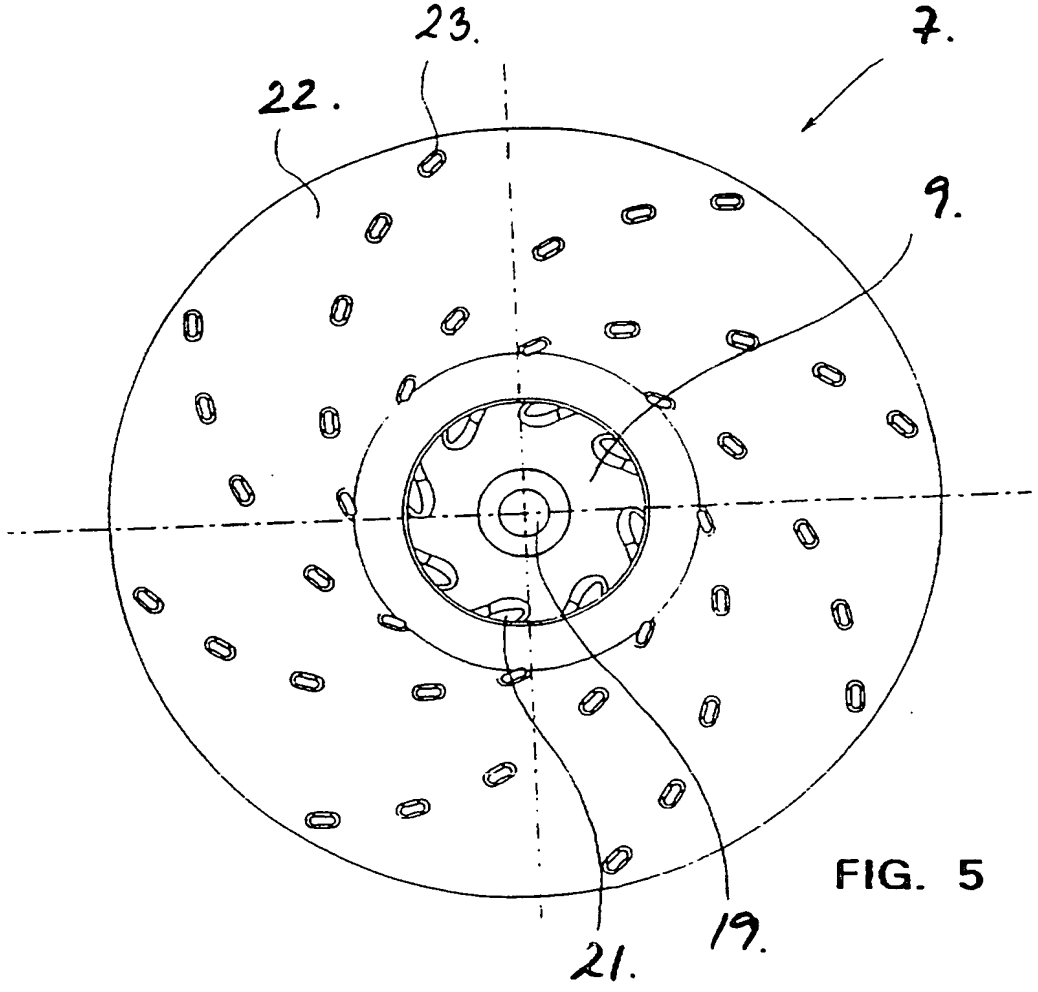

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 96/00486

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: A47L 5/22, F04D 29/44
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: A47L, F04D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3791772 A (K.K. KEIMPEMA ET AL), 12 February 1974 (12.02.74), figures 1-8, abstract --	1-10
X	EP 0556895 A1 (N.V. PHILIPS' GLOEILAMPENFABRIEKEN), 25 August 1993 (25.08.93), figures 1-3, abstract --	1-10
X	EP 0467557 A1 (HITACHI, LTD.), 22 January 1992 (22.01.92), figures 1-12, abstract -- --------	1-10

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
5 February 1997	11 -02- 1997
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Jan-Axel Ylivainio Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

28/10/96

International application No.
PCT/DK 96/00486

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		DE-D,T- 69105845	27/04/95
		EP-A,B- 0453296	23/10/91
		EP-A- 0602007	15/06/94
		JP-A- 4081600	16/03/92